IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Patent Application

Applicant(s):	A.B. Piccirilli et al.
Case:	1-75
Serial No.:	09/262,530
Filing Date:	March 4, 1999
Group:	2633
Examiner:	Agustin Bello

I hereby certify that this paper is being deposited on this date with the U.S. Postal Service as first class mail addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231.

Signature: *[signature]* Date: January 27, 2003

Title: System and Method for Secure Multiple Wavelength Communication on Optical Fibers

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APPEAL BRIEF

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Applicants hereby appeal the final rejection dated August 22, 2002 of claims 1-32 of the above-identified application.

REAL PARTY IN INTEREST

The present application is assigned to Lucent Technologies Inc., as evidenced by an assignment recorded March 4, 1999 in the U.S. Patent and Trademark Office at Reel 9809, Frame 0500. The assignee Lucent Technologies Inc. is the real party in interest.

RELATED APPEALS AND INTERFERENCES

There are no known related appeals and interferences.

STATUS OF CLAIMS

Claims 1-32 are pending in the present application. Each of claims 1-32 stands finally rejected under 35 U.S.C. §102(b) or 35 U.S.C. §103(a). Claims 1-32 are appealed.

STATUS OF AMENDMENTS

There have been no amendments filed subsequent to the final rejection.

SUMMARY OF INVENTION

The present invention is directed to methods and systems for secure optical communication. As indicated in the specification at page 1, lines 15-22, conventional techniques for secure optical communication, e.g., those involving encryption algorithms, suffer from a number of significant drawbacks, such as additional bandwidth requirements, computation-intensive protocols, and the need for key exchange. The present invention overcomes these problems by providing an arrangement in which, as described at page 2, lines 2-6:

> [A] bit stream constituting a message to be transmitted is divided into portions, and these portions are allocated among plural wavelength channels for transmission. Thus, each portion is transmitted in one assigned wavelength channel, but different portions may be transmitted in different channels.

An example of the dividing of a given signal into portions can be seen in FIG. 7, where an initial data stream 215 is separated into four portions, each of which is assigned to a corresponding one of four wavelength channels denoted λ_1, λ_2, λ_3 and λ_4. The particular portions of a given signal that are assigned to each channel may be specified through the use of recurring time windows, as described at page 6, lines 3-8 of the specification. Thus, different portions of a given signal are distributed across different wavelength channels. In order to provide additional security, the assignment of signal portions to channels can be scrambled, as illustrated in conjunction with FIG. 9 and described in the specification at page 8, line 28, to page 9, line 23.

An important advantage provided by the particular claimed arrangements is enhanced security of communication, as is described in the specification, at page 2, lines 6-10:

> As a consequence, successful reception of the original message requires both the ability to receive over the full set of wavelength channels used for transmission, and knowledge of the pattern of channel allocations, so that the portions can be reconstituted in the proper order. Security is enhanced because neither of these requirements is easily satisfied in an unauthorized interception of the transmitted signal.

It should be noted that the invention is also distinct from conventional dense wavelength division multiplexing (WDM), described at page 1, lines 5-14 of the specification. As indicated above, the invention involves separating a given signal into distinct portions and allocating the different portions to different wavelength channels. The distribution of the different portions of the given signal across the different wavelength channels provides a secure optical communication function without the drawbacks associated with the use of encryption algorithms. Dense WDM, by contrast, simply assigns different stand-alone signals to different wavelength channels, and thus fails to provide the secure communication functionality of the present invention for a given one of the stand-alone signals to be transmitted.

ISSUES PRESENTED FOR REVIEW

1. Whether claims 1, 2, 7, 9, 15, 20, 28 and 31 are properly rejected under 35 U.S.C. §102(b) as being unpatentable over U.S. Patent U.S. Patent No. 5,710,650 (hereinafter "Dugan").

2. Whether claims 3, 8, 12-14, 16, 22, 25 and 27 are properly rejected under 35 U.S.C. §103(a) as being unpatentable over Dugan in view of U.S. Patent No. 6,256,124 (hereinafter "Hait").

3. Whether claims 4-6, 17-19, 23, 24, 29 and 30 are properly rejected under 35 U.S.C. §103(a) as being unpatentable over Dugan in view of Hait and U.S. Patent No. 6,160,651 (hereinafter "Chang").

4. Whether claim 10 is properly rejected under 35 U.S.C. §103(a) over Dugan in view of an article by D. Norte et al. entitled "All-Optical TDM-to-WDM Data Format Conversion in a

Dynamically Reconfigurable WDM Network," IEEE Photonics Technology Letters, Vol. 7, No. 8, pp. 920-922, August 1995, (hereinafter "Norte I").

5. Whether claim 11 is properly rejected under 35 U.S.C. §103(a) as being unpatentable over Dugan in view of Hait, Chang and Norte I.

6. Whether claims 21 and 32 are properly rejected under 35 U.S.C. §103(a) over Dugan in view of an article by D. Norte et al. entitled "Demonstration of an All-Optical Data Format Transparent WDM-to-TDM Network Node with Extinction Ratio Enhancement for Reconfigurable WDM Networks," IEEE Photonics Technology Letters, Vol. 8, No. 5, pp. 715-717, May 1996, (hereinafter "Norte II").

7. Whether claim 26 is properly rejected under 35 U.S.C. §103(a) as being unpatentable over Dugan in view of Hait and Norte I.

GROUPING OF CLAIMS

With regard to Issue 1, claims 1, 2, 7 and 9 stand or fall together, claims 15 and 20 stand or fall together, and claims 28 and 31 stand or fall together.

With regard to Issue 2, independent claim 22 is believed to be separately patentable apart from dependent claims 3, 8, 12-14, 25 and 27 which stand or fall together.

With regard to Issue 3, claims 4-6, 17-19, 23, 24, 29 and 30 stand or fall together.

With regard to Issue 6, claims 21 and 32 stand or fall together.

ARGUMENT

Issue 1

Applicants initially note that MPEP §2131 specifies that a given claim is anticipated "only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference," citing Verdegaal Bros. v. Union Oil Co. of California, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). Moreover, MPEP §2131 indicates that the cited reference must show the "identical invention . . . in as complete detail as is contained in the . . . claim," citing Richardson v. Suzuki Motor Co., 868 F.2d 1226, 1236, 9 USPQ2d 1913, 1920 (Fed.

Cir. 1989). For the reasons identified below, Applicants submit that the Examiner has failed to establish anticipation of at least independent claims 1, 15 and 28 by Dugan.

The Examiner in the final Office Action, in the Response to Arguments section thereof, argues that Dugan anticipates independent claims 1, 15 and 28 by teaching, in column 3, lines 1-16, that four lower-rate streams can be generated from a single high-speed data stream, with each lower-rate stream being transmitted via a separate wavelength channel, and with the separate wavelength channels being multiplexed onto a single fiber. This is a type of conventional dense WDM, and fails to meet the particular limitations of independent claims 1, 15 and 28.

With regard to independent claim 1, this claim includes, among other limitations, steps (a) and (b) as follows, with emphasis supplied:

(a) assigning distinct portions of the data signal to two or more respective channels;

(b) for each channel, using corresponding assigned portions of the data signal to modulate an optical carrier signal at a respective wavelength associated with that channel.

Claim 1 therefore requires that distinct portions of a data signal be assigned to each of the channels, and that in each channel the assigned portions are used to modulate an optical carrier signal at the corresponding wavelength. The Examiner argues that Dugan, in assigning each of the four lower-rate streams noted above to a different wavelength channel, meets the limitations of claim 1. However, claim 1 clearly requires that distinct portions of the data signal itself are used to modulate an optical carrier signal associated with a corresponding wavelength channel. This is not the case in Dugan. As noted by the Examiner, the lower-rate streams, and not distinct portions of the high-speed data stream itself, modulate the optical carrier signals in Dugan. Although the lower-rate streams may be generated from the high-speed data stream, these lower-rate streams do not constitute actual portions of the high-speed data stream signal itself. Instead, the lower-rate streams are separate and distinct signals apart from the high-speed data stream signal, as is apparent from the fact that these lower-rate stream signals operate at a lower bit rate than the high-speed data stream signal. In other words, the fact that the lower-rate stream signals operate at a different bit rate than the high-

speed data stream signal is a clear indication that the former are not "portions" of the latter as would be required by claim 1.

Dugan thus discloses a type of conventional dense WDM of multiple separate and independent data signals, and not separation of one signal into distinct portions of that signal itself. As indicated above, it is the separation of a given signal into distinct portions, and distribution of these portions of the given signal across multiple wavelength channels, that provides the secure communication functionality associated with transmission of the given signal in accordance with the present invention. Conventional WDM techniques such as that described in Dugan, by failing to meet the particular claim limitations, fail to provide the associated secure communication functionality for a given signal to be transmitted.

In view of the above, Applicants respectfully submit that the Dugan reference fails to anticipate claim 1.

Dependent claims 2, 7 and 9 are believed to be allowable for at least the reasons identified above with regard to independent claim 1.

Applicants also traverse the rejection of independent claim 15 as being anticipated by Dugan. Claim 15 is directed to a method of optical communication in which different portions of a received optical signal are assembled, from distinct wavelength channels, into a single, sequential data stream. In the optical receiver 50 of Dugan FIG. 2, a 10 Gb/s received optical signal is separated into multiple independent data signals. There is no assembly of different portions of any particular received optical signal, taken from different wavelength channels, into a single, sequential data stream as claimed. Again, the Examiner has failed to give appropriate patentable weight to the claim limitations relating to portions of a given signal, asserting that these claim limitations are met by arrangements involving WDM of separate, stand-alone signals.

Dependent claim 20 is believed to be allowable for at least the reasons identified above with regard to independent claim 15.

Applicants similarly traverse the rejection of independent claim 28 as being anticipated by Dugan. Claim 28 calls for an optical communication system in which a received input optical signal that contains data content in two or more distinct wavelength channels is separated into portions based on wavelength, with the portions being assembled into a single, sequential data stream. Again,

this claimed arrangement is simply not present in the Dugan reference. As noted above, in the optical receiver 50 of Dugan FIG. 2, a 10 Gb/s received optical signal is separated into multiple independent data signals, but there is no assembly of different portions of any particular received optical signal, taken from different wavelength channels, into a single, sequential data stream as claimed.

Dependent claim 31 is believed to be allowable for at least the reasons identified above with regard to independent claim 28.

Applicants therefore respectfully submit that the §102(b) rejection is improper, and should be withdrawn.

Issue 2

With regard to independent claim 22, this claim calls for apportioning the data content of a data signal into two or more distinct wavelength channels according to defined time windows such that each channel receives a portion of the data content during its assigned time window. The Examiner acknowledges that Dugan fails to teach at least the "time windows" limitations of claim 22, but argues that Hait supplies these missing teachings.

However, Applicants note that the above-described deficiencies of the Dugan reference also render the §103(a) rejection of claim 22 improper. More particularly, for reasons similar to those given above in conjunction with independent claims 1, 15 and 28, Dugan fails to teach the claimed apportioning of data content of a data signal into two or more distinct wavelength channels, and the output optical signal containing portions of the data content in two or more wavelength channels, as set forth in claim 22. Instead, the optical transmitter 10 in Dugan FIG. 1 simply combines multiple and independent data signals into a higher-rate optical signal via conventional dense WDM techniques. The Hait reference fails to remedy this fundamental deficiency of the Dugan reference, and as a result the proposed combination of Dugan and Hait fails to meet the limitations of claim 22. The §103(a) rejection of claim 22 is therefore believed to be improper and should be withdrawn.

Dependent claims 3, 8, 12-14, 25 and 27 are believed to be allowable for at least the reasons identified above with regard to their respective independent claims.

Moreover, with regard to dependent claim 3, this claim calls for allocation of a recurring time window to a particular channel, the recurring time window identifying the particular portions of a given signal that will be assigned to that channel. The Examiner in the final Office Action acknowledges that Dugan fails to meet this limitation, but relies instead on column 2, lines 18-25, column 4, lines 33-50 and column 5, lines 1-11 and 26-31 of Hait as showing the limitation. However, the cited portions of Hait also fail to meet the particular limitation in question. Therefore, even if combinable in the manner urged by the Examiner, Hait and Dugan fail to teach or suggest all of the limitations of claim 3.

Issue 3

Dependent claims 4-6, 17-19, 23, 24, 29 and 30 are believed allowable for at least the reasons identified above with regard to their corresponding independent claims.

Moreover, one or more of these claims define additional patentable subject matter. For example, claim 4 calls for permuting the recurring time windows allocated to the channels, such that data content carried in the transmitted optical output signal occurs in a different sequence from the data content provided in the data signal. The Examiner in the final Office Action acknowledges that this limitation is not met by Dugan and Hait, but argues that the limitation is shown in column 5, lines 62-67 and column 6, lines 1-21 of Chang. Applicants respectfully disagree. There is no teaching in the cited portions of Chang regarding the claimed permutation of recurring time windows. As a result, even if one were to assume that Dugan, Hait and Chang are combinable in the manner urged by the Examiner, their combined teachings fail to teach or suggest all of the limitations of claim 4.

Issue 4

Dependent claim 10 depends from claim 1 and is therefore believed allowable for at least the reasons identified above with regard to claim 1.

Moreover, claim 10 specifies that the modulating step (b) of claim 1 further includes the steps of:

(a) providing optical radiation at two or more wavelengths to be referred to as coding wavelengths; and

(b) mixing a respective portion of the data signal with optical radiation at each of the coding wavelengths in a nonlinear optical device, thereby to generate modulated radiation having a wavelength different from the wavelength λ_D and the coding wavelengths.

The Examiner in the final Office Action acknowledges that Dugan fails to meet these limitations, but argues that the limitations at issue are shown in Norte I. Applicants respectfully disagree. Norte I teaches TDM-to-WDM data format conversion. It does not teach or suggest the particular limitations of claim 10 as specified above. Therefore, even if one assumes that Dugan and Norte I are combinable in the manner urged by the Examiner, their combined teachings fail to teach or suggest all of the claim limitations.

Issue 5

Dependent claim 11 depends from independent claim 1 and is therefore believed allowable for at least the reasons identified above with regard to claim 1.

Moreover, claim 11 further defines the assigning step (a) of claim 1, introduces limitations relating to recurring time windows, and further defines the nonlinear mixing operation associated with step (b) of claim 10. The Examiner in the final Office Action acknowledges that the Dugan, Hait and Chang references fail to meet these specific limitations of claim 11, but argues that the limitations at issue are shown in Norte I. Applicants respectfully disagree. Norte I teaches TDM-to-WDM data format conversion. It does not teach or suggest the particular limitations of claim 11 as specified above. Therefore, even if one assumes that Dugan, Hait, Chang and Norte I are combinable in the manner urged by the Examiner, their combined teachings fail to teach or suggest all of the claim limitations.

Issue 6

Dependent claims 21 and 32 depend from claims 15 and 22, respectively, and are believed allowable for at least the reasons identified above with regard to these independent claims. As

described in detail above, the Dugan reference is deficient for failing to teach or suggest certain limitations of claims 15 and 22. The Examiner in the final Office Action acknowledges that Dugan fails to meet the particular limitations of claims 21 or 32, but argues that these limitations are met by Norte II. Applicants respectfully disagree. Norte II teaches WDM-to-TDM data format conversion. It fails to supplement the fundamental deficiencies of Dugan as applied to claims 21 and 32. Therefore, even if one assumes that Dugan and Norte II are combinable in the manner urged by the Examiner, their combined teachings fail to teach or suggest all of the limitations in each of claims 21 and 32.

Issue 7

Dependent claim 26 depends from claim 22 and is therefore believed allowable for at least the reasons identified above with regard to claim 22. Neither Hait or Norte I remedy the fundamental deficiency of Dugan as applied to claim 22 above.

In view of the above, Applicants believe that claims 1-32 are in condition for allowance, and respectfully request the withdrawal of the §102(b) and §103(a) rejections.

Respectfully submitted,

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Date: January 27, 2003

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APPENDIX

1. A method for transmitting data content provided in a data signal, comprising:

a) assigning distinct portions of the data signal to two or more respective channels;

b) for each channel, using corresponding assigned portions of the data signal to modulate an optical carrier signal at a respective wavelength associated with that channel; and

c) transmitting an optical output signal that comprises modulated carrier energy at each of the respective wavelengths, such that data content is carried, in the transmitted output optical signal, by energy at two or more of the respective wavelengths.

2. The method of claim 1, wherein the modulated carrier energy is transmitted in sequential segments, each such segment having a respective wavelength.

3. The method of claim 1, wherein the assigning step comprises assigning, to each channel, those portions of the data signal that coincide with a recurring time window allocated to that channel.

4. The method of claim 3, further comprising permuting the recurring time windows allocated to the channels, such that data content carried in the transmitted optical output signal occurs in a different sequence from the data content provided in the data signal.

5. The method of claim 4, wherein the permuting step is carried out using delay lines.

6. The method of claim 5 further comprising transmitting, as part of the optical output signal, information that describes how the time windows were permuted.

7. The method of claim 1, wherein the transmitting step comprises launching the optical output signal into an optical fiber.

8. The method of claim 1, wherein the transmitting step comprises launching the optical output signal into free space.

9. The method of claim 1, wherein:

a) the data signal is an electrical signal;

b) the assigning step comprises deriving two or more electrical driver signals from the data signal, each driver signal corresponding to a respective channel; and

c) the modulating step comprises using each driver signal to cause a respective optical emission device to emit an optical signal at a respective wavelength.

10. The method of claim 1, wherein the data signal is an optical signal having a wavelength λ_D, and the modulating step comprises:

a) providing optical radiation at two or more wavelengths to be referred to as coding wavelengths; and

b) mixing a respective portion of the data signal with optical radiation at each of the coding wavelengths in a nonlinear optical device, thereby to generate modulated radiation having a wavelength different from the wavelength λ_D and the coding wavelengths.

11. (Amended) The method of claim 10, wherein:

a) the assigning step comprises assigning, to each channel, those portions of the data signal that coincide with a recurring time window allocated to that channel;

b) the optical radiation at each of the coding wavelengths is provided in the form of a train of pulses;

c) each train of pulses corresponds to a recurring time window allocated to one of the channels; and

d) the respective wavelength associated with each of the channels is a wavelength of modulated radiation generated by said non-linear mixing.

12. The method of claim 1, wherein:

a) the data signal is an electrical signal;

b) the method further comprises operating a tunable light source to produce output radiation that varies stepwise in wavelength according to a pattern; and

c) the assigning and modulating steps comprise using the data signal to modulate the output radiation such that each portion of the data signal is modulated onto an assigned wavelength of output radiation.

13. (Amended) The method of claim 12, wherein the output radiation is generated by operating a voltage-tunable laser.

14. (Amended) The method of claim 12, wherein the pattern of wavelength variation defines respective, recurring time windows during which data content is to be allocated to corresponding wavelength channels.

15. A method of optical communication, comprising:

receiving an optical signal that contains energy in two or more distinct wavelength channels;

assembling portions of the received optical signal, from distinct wavelength channels, into a single sequential data stream; and

recovering data content from the assembled data stream.

16. The method of claim 15, wherein:

a) the method further comprises providing timing information that defines a succession of time windows for each of the channels; and

b) the assembling of signal portions is carried out in accordance with the timing information, such that in the assembled data stream, each portion of the received optical signal falls in assigned time windows according to the channel in which such portion was received.

17. The method of claim 16, wherein the received optical signal falls in time windows having a permuted sequence, and the method further comprises applying an inverse permutation to the time windows, such that data content carried in the received optical signal is restored to an original sequence.

18. The method of claim 17, wherein the inverse permutation is carried out using delay lines.

19. The method of claim 18, further comprising decoding, from the received optical signal, information that describes how the time windows were permuted.

20. (Amended) The method of claim 15, wherein:

a) the method further comprises optically demultiplexing the received signal, thereby to provide two or more single-channel optical signals;

b) the method further comprises detecting each of the single-channel signals, thereby to provide two or more single-channel electronic signals; and

c) the assembling step comprises electronically multiplexing the single-channel electronic signals.

21. The method of claim 15, wherein:

a) the method further comprises optically demultiplexing the received signal, thereby to provide two or more single-channel optical signals;

b) the method further comprises shifting each of the single-channel signals into a common wavelength channel by non-linear optical mixing; and

c) the assembling step is carried out by optical multiplexing.

22. An optical communication system, comprising:

a source of a data signal having data content;

a system operative to apportion the data content into two or more distinct wavelength channels according to defined time windows such that each said channel receives a portion of the data content during its assigned time windows; and

an output element operative to couple an output optical signal into a transmission medium, wherein said output optical signal contains portions of the data content in two or more wavelength channels.

23. The optical communication system of claim 22, further comprising a scrambling element operative to permute the time windows, such that data content carried in the optical output signal occurs in a different sequence from the data content provided in the data signal.

24. The optical communication system of claim 23, wherein the scrambling element comprises delay lines.

25. (Amended) The optical communication system of claim 22, wherein:

the data signal source is an electronic signal source;

the apportioning system comprises an electronic demultiplexer operative in response to the data signal to generate two or more distinct driver signals;

the apportioning system further comprises a respective optically emissive device operative in response to each driver signal to generate a corresponding optical signal in a distinct wavelength channel; and

the output element comprises an optical multiplexer operative to combine the respective optical signals and couple them into the transmission medium.

26. The optical communication system of claim 22, wherein:

the data signal source is an optical signal source; and

the apportioning system comprises a nonlinear optical device operative to shift selected portions of the data signal into respective wavelength channels.

27. The optical communication system of claim 22, wherein:

the data signal source is an electrical signal source;

the apportioning system comprises a voltage-tunable laser operative, in response to a voltage pattern, to emit radiation that, in respective time windows, occupies corresponding wavelength channels; and

the apportioning system further comprises a modulator, operative in response to the data signal to impose data content on the radiation emitted by the voltage-tunable laser.

28. An optical communication system, comprising:

a device operative to receive an input optical signal that contains data content in two or more distinct wavelength channels, and operative to separate portions of said input signal according to wavelength; and

a device operative to assemble said portions into a single, sequential data stream.

29. The optical communication system of claim 28, wherein: each wavelength channel is received in a respective recurring time window, the time windows are permuted such that data content is received in a sequence that differs from an original sequence, and the system further comprises an unscrambling element operative to permute the time windows, such that assembly of the portions into a single, sequential data stream will cause data content to occur in the original sequence.

30. The optical communication system of claim 28, wherein the unscrambling element comprises delay lines.

31. The optical communication system of claim 28, wherein:

the signal-receiving and separating device is an optical demultiplexer;

the optical communication system further comprises two or more optical receivers, each operative to convert optical signal portions in a respective wavelength channel to corresponding electrical signal portions; and

the assembling device comprises an electronic multiplexer in receiving relationship to said electrical signal portions.

32. The optical communication system of claim 28, wherein:

the signal-receiving and separating device is an optical demultiplexer;

the optical communication system further comprises two or more nonlinear optical devices, each operative to shift optical signal portions in a respective wavelength channel into a common wavelength channel; and

the assembling device comprises an optical multiplexer in receiving relationship to the optically shifted signal portions.

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I hereby certify that this paper is being deposited on this date with the U.S. Postal Service as first class mail addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231.

Signature: Lura M. Hanlin Date: January 27, 2003

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TRANSMITTAL OF APPEAL BRIEF

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Submitted herewith are the following documents relating to the above-identified patent application:

(1) Appeal Brief in triplicate (original and two copies); and
(2) Copy of Notice of Appeal, filed on November 22, 2002, with copy of stamped return postcard indicating receipt of Notice by PTO on November 27, 2002.

There is an additional fee of $320 due in conjunction with this submission under 37 CFR §1.17(c). Please charge **Ryan, Mason & Lewis, LLP Account No. 50-0762** the amount of $320, to cover this fee. In the event of non-payment or improper payment of a required fee, the Commissioner is authorized to charge or to credit **Deposit Account No. 50-0762** as required to correct the error. A duplicate copy of this letter and two copies of the Appeal Brief are enclosed.

Respectfully submitted,

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Date: January 27, 2003

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